Docket No. 03-0418

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

APPEAL NO. ____________________

First named inventor:
Maurice Peter Bianchi

Confirmation No. 2668

Serial No. 10/806,710

Filed: June 23, 2004

Examiner: Shannon Gardner

Art Unit: 1795

Title: SOLAR CELL ASSEMBLY

APPEAL BRIEF

Hugh P. Gortler, Esq.

(949) 454-0898

TABLE OF CONTENTS

1. REAL PARTY IN INTEREST

The real party in interest is the assignee, The Boeing Company.

2. RELATED APPEALS AND INTERFERENCES

No appeals or interferences are known to have a bearing on the Board's decision in the pending appeal.

3. STATUS OF CLAIMS

Claims 3, 17-19 and 23-24 are cancelled.

Claims 1, 2, 4-16 and 20-22 and 25 are pending.

Claims 1, 2, 4-16, 20-22, and 25 are rejected.

The rejections of claims 1, 2, 4-5, 7-12, 15-16, 20-22, and 25 are being appealed.

4. STATUS OF AMENDMENTS

No amendment was filed subsequent to the final rejection dated Nov. 28, 2008.

5. SUMMARY OF CLAIMED SUBJECT MATTER

The original application filed 3 March 2004 does not contain liner numbers. Therefore, reference will be made to paragraph numbers in the corresponding publication, United States Patent Application No. 20050211291.

Base claim 1

Base claim 1 recites a multi-junction solar cell assembly. Figure 1 illustrates an example of such a solar cell assembly 20. The solar cell assembly 20 of Figure 1 includes a transparent substrate 22 (paragraph 15) and a

transparent conductive coating ("TCC") 24 formed on the transparent substrate 22 (paragraph 16). The TCC functions as a collector for conducting solar photon-generated current from the surface of a cell. The transparent conductive coating comprises gallium nitride to provide a defect-free surface for growing an InGaN solar cell (paragraph 20).

An example of such a TCC is illustrated in Figures 4A-4C. A lateral epitaxial overgrowth layer (generally designated by 48) is formed on the substrate 22 "to reduce defects in the TCC caused by a lattice mismatch between the TCC and the substrate" (paragraph 19). The overgrowth layer is grown in a way that prevents dislocations from propagating into subsequent growth layers formed on the lateral epitaxial overgrowth layer (paragraph 20). Defect-free layers of GaN can be formed on the lateral epitaxial overgrowth layer 48 to generally form the TCC 24 on the transparent substrate 22 without defects, despite a lattice mismatch between the TCC and the substrate (paragraph 20).

The solar cell assembly 20 further includes a solar cell including a plurality of gallium indium nitride junction layers 26 grown successively on the transparent conductive coating (paragraphs 21-22); an indium nitride junction layer 34 formed on the plurality of gallium indium nitride junction layers (paragraph 14); and a metallization layer 28 formed on the indium nitride junction layer 34 (paragraph 14).

Each successive gallium indium nitride junction laver has a thickness greater than a thickness of the immediately preceding gallium indium nitride junction layer (paragraph 25). Each successive gallium indium nitride junction layer is directly adjacent the immediately preceding gallium indium nitride junction layer.

Base claim 20

Base claim 20 recites a method of forming a unitary multi junction solar cell assembly. The method comprises forming a transparent conductive coating 24 including gallium nitride on a sapphire cover 22 (Figures 4A-4C and paragraphs 19-20). The method further comprises growing a solar cell including a plurality of gallium indium nitride junction layers 26 on the transparent conductive coating 24 without taking any measures to correct for lattice mismatch (Figure 1 and paragraphs 21-22).

Paragraph 2 of the Background section explains why corrective measures were needed in conventional solar cell assemblies. Lattice mismatches between the TCC and a solar cell may cause dislocations or defects that reduce solar cell efficiency.

In conventional solar cell assemblies, corrective measures are taken to correct for lattice mismatches between the TCC and the solar cell. For example, adhesive is used to attach the cover to the solar cell. However, the corrective measures can have undesirable consequences. According to the Background of the application, the adhesive can darken and thereby reduce efficiency through solar obscuration (paragraph 2).

The applicant discloses that the TCC can be modified to avoid the need for corrective measures. As explained in paragraphs 19-20 of the specification, a GaN TCC according to the present invention provides a defect-free surface for growing an InGaN solar cell. This unexpected result provides real benefits. It allows the InGaN solar cell to be grown on the TCC/sapphire cover, thus forming a unitary assembly. No adhesive is needed to attach the cover to the solar cell. No other corrective measures are made to the solar cell.

Base claim 25

Base claim 25 recites a solar cell assembly. The solar cell assembly comprises a sapphire cover 22 (Figure 1 and paragraph 15) and a GaN transparent conductive coating (TCC) 24 as front collector. The GaN TCC 24 is formed on the sapphire cover 22 (Figure 1 and paragraph 16; and Figures 4A-4C and paragraphs 19-20).

The solar assembly further comprises a multjunction InGaN solar cell grown on a GaN layer of the TCC (Figure 1 and paragraphs 21-22 describe a mutlijunction solar cell having multiple layers of InGaN junction layers 26). As explained in paragraphs 19-20 of the specification, the GaN TCC provides a defect-free surface upon which the InGaN solar cell is grown. This unexpected result provides real benefits. It allows the InGaN solar cell to be grown on the TCC/sapphire cover, thus forming a unitary assembly. In contrast, prior solar cell assemblies used adhesive to attach the cover to the solar cell. In the solar cell assembly of claim 25, no such corrective measures are needed.

Dependent claim 11

Claim 11 should depend from claim 25. Although it presently depends from claim 24, the examiner correctly examined it as a dependent claim of base claim 25

Claim 11 recites that the transparent conductive coating comprises a nucleation layer formed on the sapphire cover; a lateral epitaxial overgrowth layer of gallium nitride formed on the nucleation layer; and a defect-free gallium nitride layer formed on the lateral epitaxial overgrowth layer. As

illustrated in Figures 4A-4C, a lateral epitaxial overgrowth layer (generally designated by 48) is formed on the transparent substrate 22 “to reduce defects in the TCC caused by a lattice mismatch between the TCC and the substrate” (paragraph 19). The overgrowth layer is grown in a way that prevents dislocations from propagating into subsequent growth layers formed on the lateral epitaxial overgrowth layer (paragraph 20). Defect-free layers of GaN can be formed on the lateral epitaxial overgrowth layer 48 to generally form the TCC 24 on the transparent substrate 22 without defects, despite a lattice mismatch between the TCC and the substrate (paragraph 20).

6. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

a. Rejection of claims 20-22 under 35 USC §112, first paragraph as not complying with the written description requirement.

b. Rejection of claims 1-2, 4-5, 7-12 15-16, 20 and 25 under 35 USC §103(a) as being unpatentable over Bour EP 977,279 in view of a paper by Wu et al. entitled “Superior radiation resistance in InGaN alloys”), and Schetzina U.S. Patent No. 5,679,965.

7. ARGUMENTS

I
REJECTION OF CLAIMS 20-22 UNDER 35 USC §112, FIRST PARAGRAPH AS NOT COMPLYING WITH THE WRITTEN DESCRIPTION REQUIREMENT

The office action alleges that the specification does not provide support for the feature "growing a solar cell including a plurality of gallium indium nitride junction layers on the transparent conductive coating without taking any measures to correct for lattice mismatch." We respectfully disagree.

Paragraphs 19-20 of the specification describe a TCC that provides a defect free surface upon which a solar cell can be grown. Paragraphs 21-23 and 33 describe a solar cell that can be grown on the TCC, thus forming a unitary assembly.

Because the assembly is unitary, the solar cell does not have to be attached to the TCC by an adhesive (in contrast to a solar cell described in the Background of the application). Thus, no adhesive or other corrective measure is needed to attach the solar cell to the TCC (paragraph 33).

To satisfy the written description requirement, a patent specification must describe the claimed invention in sufficient detail that one skilled in the art can reasonably conclude that the inventor had possession of the claimed invention. See, e.g., *Moba, B.V. v. Diamond Automation, Inc.*, 325 F.3d 1306, 1319, 66 USPQ2d 1429, 1438 (Fed. Cir. 2003).

The specification clearly provides support for a unitary assembly that avoids the use of adhesive or other measures to correct for lattice mismatch between the solar cell and TCC. Therefore, the specification satisfies the written description requirement. Accordingly, the '112 rejection of base claims 20-22 should be withdrawn.

II

REJECTION OF CLAIMS 1-2, 4-5, 7-12 15-16, 20 AND 25 UNDER 35 USC §103(A) AS BEING UNPATENTABLE OVER BOUR EP 977,279 IN VIEW OF A PAPER BY WU ET AL. ("SUPERIOR RADIATION RESISTANCE IN INGAN ALLOYS") AND SCHETZINA U.S. PATENT NO. 5,679,965

Claims 1-2, 4-5, 7-10, 12, 15-16, 20 and 25

The three documents cited in the '103 rejection do not teach or suggest a solar cell assembly including a transparent conductive coating (TCC) comprising gallium nitride (GaN) in combination with an InGaN solar cell Of the three cited documents, only the Wu paper provides evidence of InGaN solar cells (Bour and Schetzina relate to laser diodes).

However, Wu is silent about covers for their InGaN solar cell. Wu is also silent about lattice mismatches with substrates upon which their solar cell is grown.

Wu mentions problems with high-energy particle damage to InGaN solar cells, but offer no solutions. Wu states that "Work on InGaN has not yet progressed to the point of making complete devices, so we have chosen to study here basic material properties" (p. 6478, left column).

Thus, Wu provides clear evidence that the state of the art has not progressed to issues involved with making complete devices. These issues include overcoming problems with lattice mismatches between InGaN solar cells their underlying substrates.

Wu offers no evidence of solving the lattice mismatch problem. The only evidence of record is provided in the Background of the application, which describes the use of adhesives to bond a solar cell to a cover. However, as the Background points out, adhesives can have undesirable consequences.

The applicant discloses and claims an assembly that Wu mentions as "not yet progressed to the point. The applicant discloses that by modifying the TCC, corrective measures to the InGaN solar cell can be avoided. As explained in paragraphs 19-20 of the specification, a GaN TCC according to the present invention provides a defect-free surface for growing an InGaN solar cell. This unexpected result allows the InGaN solar cell to be grown on the TCC, thus forming a unitary assembly. No adhesive is needed to attach the solar cell to the TCC. No corrective measures to the solar cell have to be made to grow it on a cover.

The other two cited documents don't contradict Wu's assertion "Work on InGaN has not yet progressed to the point of making complete devices," nor do they address the lattice mismatch problem with InGaN solar cells.

Bour discloses a laser diode having a sapphire substrate 305, a thin amorphous buffer layer 310 of GaN, and thick and active InGaN layers 320 and 330. The buffer layer 310 serves as a nucleation layer. Paragraph 28 says the thick layer 320 allows higher indium content to be used in the active layer 330. Growing the active layer 330 on the thick layer 320 results in less lattice mismatch than growing the active layer 330 directly on the GaN buffer layer 310.

Schetzina discloses a semiconductor surface emitting laser having a lattice matched structure including a sapphire substrate, and a GaN layer, graded AlGaN layers and InGaN active layer. A multiple quantum well may be used instead of the graded layers of AlGaN.

Bour and Schetzina teach that corrective measures (e.g., additional layers) are taken to overcome problems with lattice mismatches. However, as the applicant has found, such work is not necessary for the combination of a GaN TCC and an InGaN solar cell.

The latest office action alleges that col. 7, lines 37-42 of Bour discloses a transparent TCC for providing defect-free surface for growing an InGaN solar cell, and col. 8, lines 16-19 disclose growing an InGaN solar cell on the TCC. Page 4 of the office action states “It is the Examiner’s position that as the transparent substrate taught by Bour can be of sapphire and the TCC coating is the same as the material of the instant claim, that the substrate and coating will provide a defect free surface for growing the InGaN solar cell.”

Bour does not support the allegations or the examiner’s position. Bour relates to laser diodes (col. 7, line 21), not solar cells. Bour’s structure is designed to emit light, not convert light to electrical energy. Bour does not disclose a structure that functions as a collector for conducting solar photon-generated current from the surface of a cell. Thus, Bour does not disclose a TCC or a solar cell (InGaN or otherwise).

At column 7, lines 37-42 describe a buffer layer 410 on a sapphire substrate. Bour indicates several possible materials for the buffer layer 410, including GaN. However, there is no recognition of a GaN layer as a TCC, let alone one that provides a defect free surface upon which an InGaN solar cell can be grown. Rather, the buffer layer 410 serves as a nucleation layer for a thick InGaN layer of a laser diode 400.

As for column 8, lines 16-19 describe a structure for emitting light. Please see line 20. Column 8 in particular, and Bour in general, are silent about solar cells of any kind.

The combined teachings of Wu, Bour and Schetzina do not produce the solar cell assembly of base claim 1, the method of base claim 20, or the solar cell assembly of base claim 25. All three documents are ***silent*** about a TCC that provides a defect-free surface for an InGaN solar cell. Therefore, the ‘103

rejection of base claims 1, 20 and 25 and their dependent claims should be withdrawn.

Claim 11

Although claim 11 incorrectly depends from cancelled claim 24, the examiner correctly examined it as a dependent claim of base claim 25. Thus, claim 11 recites a GaN transparent conductive coating (TCC) as front collector, the GaN TCC formed on sapphire cover; and a multjunction InGaN solar cell grown on a GaN layer of the TCC; wherein the transparent conductive coating comprises a nucleation layer formed on the sapphire cover; a lateral epitaxial overgrowth layer of gallium nitride formed on the nucleation layer; and a defect-free gallium nitride layer formed on the lateral epitaxial overgrowth layer.

The three cited documents are silent about the TCC of claim 11

The office action refers to paragraph 25, which describes a multi-layer LED structure 300 including a nucleation layer 310 on a substrate 305. The office action alleges that col. 5, lines 40-45 describe a lateral epitaxial growth layer of GaN formed on a nucleation layer. However, col. 5, lines 40-45 describes the nucleation layer 310, not a layer on top of it.

Bour is silent about a lateral epitaxial overgrowth layer of gallium nitride formed on the nucleation layer. Bour discloses either another GaN buffer layer 312 on the nucleation layer 310 (paragraph 26), or a layer of a light-emitting diode (paragraph 27).

Thus, the office action has not established prima facie obviousness of claim 11. Therefore, the ‘103 rejection of claim 11 should be withdrawn.

For the reasons above, the rejections should be reversed. The Honorable Board of Patent Appeals and Interferences is respectfully requested to reverse these rejections.

Respectfully submitted,

/Hugh Gortler #33,890/
Hugh P. Gortler
Reg. No. 33,890

Date: June 22, 2009

8. CLAIMS APPENDIX

Claims 20-25 were numbered incorrectly in the response filed 14 August 2008. The final office action renumbered those claims as follows. Please note that claims 21 and 22 should depend from claim 20 instead of claim 19, and that claims 5, 11 and 13 should depend from claim 25 instead of claim 24. The incorrect dependency of these claims does not affect the issues on appeal.

1. (Previously presented) A multi-junction solar cell assembly comprising:

a transparent substrate;

a transparent conductive coating formed on the transparent substrate, said transparent conductive coating comprising gallium nitride to provide a defect-free surface for growing an InGaN solar cell;

a solar cell including a plurality of gallium indium nitride junction layers grown successively on the transparent conductive coating;

an indium nitride junction layer formed on the plurality of gallium indium nitride junction layers; and

a metallization layer formed on the indium nitride junction layer;

wherein each successive gallium indium nitride junction laver has a thickness greater than a thickness of the immediately preceding gallium

indium nitride junction layer, each successive gallium indium nitride junction layer being directly adjacent the immediately preceding gallium indium nitride junction layer.

2. (Original) A multi junction solar cell assembly in accordance with claim 1 wherein the transparent substrate is selected from a group of transparent substrates consisting of sapphire, zinc oxide, and gallium nitride.

3. (Canceled).

4. (Previously presented) A multi junction solar cell assembly in accordance with claim 1 further comprising a gallium nitride junction layer between the transparent conductive coating and the plurality of gallium Indium nitride junction layers.

5. (Previously presented) The solar cell assembly of claim 24, wherein the solar cell includes a plurality of gallium indium nitride junction layers having a thickness of between about 0.2 microns and about 1.0 microns.

6. (Canceled).

7. (Previously presented) The solar cell assembly of claim 5, wherein each layer of the plurality of gallium indium nitride junction layers has a gallium content of between about 90 wt % and about 10 wt % and an indium content of between about 90 wt % and about 10 wt %.

8. (Previously presented) The solar cell assembly of claim 5, wherein each successive layer of the plurality of gallium indium nitride junction layers has a gallium content less than the immediately preceding layer of the plurality of gallium indium nitride junction layers and an indium content greater than the immediately preceding layer of the plurality of gallium indium nitride junction layers.

9. (Previously presented) The solar cell assembly of claim 5, wherein each layer of the plurality of gallium indium nitride junction layers has a band gap of between about 0.7 eV and about 3.4 eV.

10. (Previously presented) The solar cell assembly of claim 5, wherein each successive layer of the plurality of gallium indium nitride junction layers has a band gap less than the band gap of the immediately preceding layer of the plurality of gallium indium nitride junction layers.

11. (Previously presented) The solar cell assembly of claim 24, wherein the transparent conductive coating comprises:

a nucleation layer formed on the sapphire cover;

a lateral epitaxial overgrowth layer of gallium nitride formed on the nucleation layer; and

a defect-free gallium nitride layer formed on the lateral epitaxial overgrowth layer.

12. (Previously presented) The solar cell assembly of claim 11, wherein the nucleation layer comprises:

an aluminum nitride coating formed directly on the sapphire cover in intimate contact with the sapphire cover; and

a seed layer of gallium nitride formed on the aluminum nitride coating.

13. (Previously presented) The solar cell assembly of claim 24, wherein the transparent conductive coating comprises:

a plurality of alternating layers of gallium nitride and aluminum gallium nitride; and

a plurality of quantum wells, each quantum well of the plurality of quantum wells formed at a corresponding interface between adjacent layers of gallium nitride and aluminum gallium nitride of the plurality of alternating layers of gallium nitride and aluminum gallium nitride.

14. (Previously presented) The solar cell assembly of claim 13 wherein a first gallium indium nitride junction layer of the plurality of gallium indium nitride junction layers is formed directly on a last gallium nitride layer of the plurality of alternating layers of gallium nitride and aluminum gallium nitride in

intimate contact with the last gallium nitride layer of the plurality of alternating layers of gallium nitride and aluminum gallium nitride.

15. (Original) A multi junction solar cell assembly in accordance with claim 1 wherein the transparent conductive coating comprises a gallium nitride layer formed on the transparent substrate.

16. (Previously presented) The solar cell assembly of claim 5, further comprising a metal current collector bus for receiving electrical power collected from the plurality of gallium indium nitride junction layers by the transparent conductive coating.

17-19 (Cancelled)

20. (Previously presented) A method of forming a unitary multi junction solar cell assembly comprising:

forming a transparent conductive coating including gallium nitride on a sapphire cover; and

growing a solar cell including a plurality of gallium indium nitride junction layers on the transparent conductive coating without taking any measures to correct for lattice mismatch.

21. (Previously presented) A method in accordance with claim 19 further comprising forming a metallization layer on the plurality of gallium

indium nitride junction layers, wherein the metallization layer is selected from a group that includes a layer of aluminum, a layer of chromium, and a layer of titanium; and forming an Indium nitride junction layer on the plurality of gallium indium nitride junction layers between the metallization layer and the plurality of gallium indium nitride junction layers.

22 (Original) A method in accordance with claim 19 further comprising forming a gallium nitride junction layer on the transparent conductive coating between the transparent conductive coating and the plurality of gallium indium nitride junction layers.

23-24. (Cancelled)

25. (Previously presented) A solar cell assembly comprising:

a sapphire cover;

a GaN transparent conductive coating (TCC) as front collector, the GaN TCC formed on the sapphire cover; and

a multjunction InGaN solar cell grown on a GaN layer of the TCC;

wherein the GaN TCC provides a defect-free surface upon which the InGaN solar cell is grown.

9. EVIDENCE APPENDIX

None

10. RELATED PROCEEDINGS APPENDIX

None